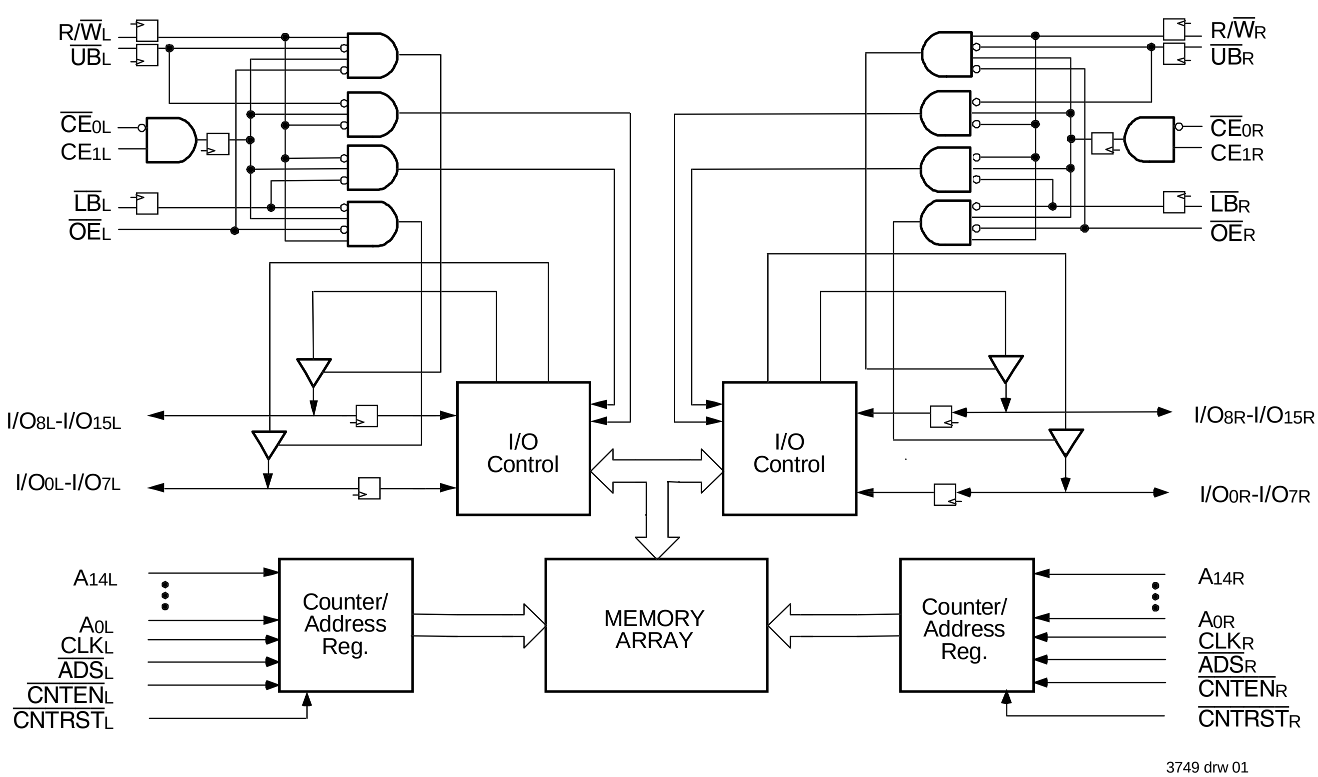
HIGH-SPEED 3.3V 32K x 16 SYNCHRONOUS DUAL-PORT STATIC RAM

PRELIMINARY
IDT70V927S/L

Features

- **True Dual-Ported memory cells which allow simultaneous access of the same memory location**
- **High-speed clock to data access**
  - *Commercial: 25/30ns*
- **Low-power operation**
  - *IDT70V927S*
    Active: 550mW (typ.)
    Standby: 3.3mW (typ.)
  - *IDT70V927L*
    Active: 550mW (typ.)
    Standby: 660mW (typ.)
- **Flow-Through output mode**
- **Counter enable and reset features**
- **Dual chip enables allow for depth expansion without additional logic**
- **Full synchronous operation on both ports**
  - *4ns setup to clock and 1ns hold on all control, data, and address inputs*
  - *Data input, address, and control registers*
  - *Fast 25ns clock to data out*
  - *Self-timed write allows fast cycle time*
  - *30ns cycle time, 33MHz operation*
- **Separate upper-byte and lower-byte controls for multiplexed bus and bus matching compatibility**
- **LVTTL- compatible, single 3.3V (±0.3V) power supply**
- **Industrial temperature range (-40°C to +85°C) is available for selected speeds**
- **Available in a 128 pin Thin Quad Flatpack**

Functional Block Diagram



3749 drw 01

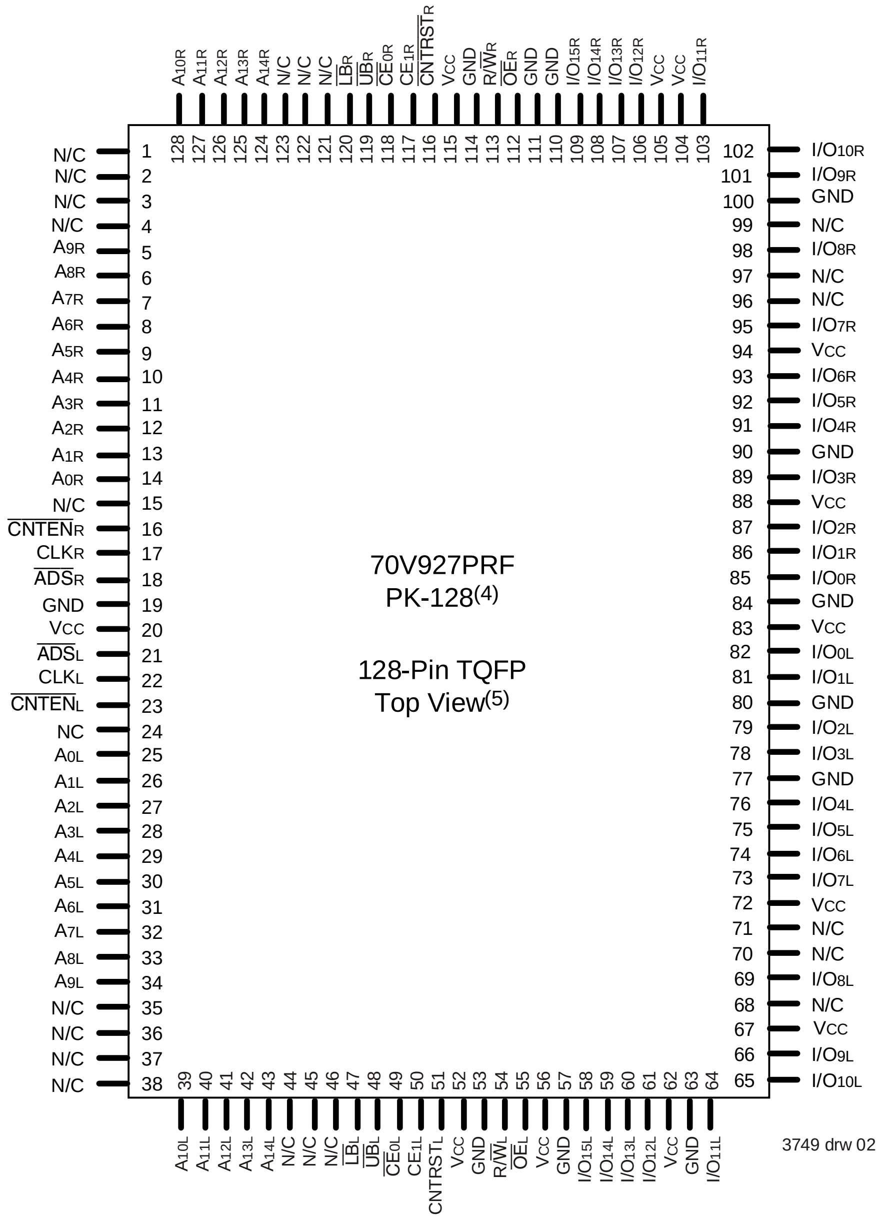
SEPTEMBER 1999

Description

The IDT70V927 is a high-speed 32K x 16 bit synchronous Dual-Port RAM. The memory array utilizes Dual-Port memory cells to allow simultaneous access of any address from both ports. Registers on control, data, and address inputs provide minimal setup and hold times. The timing latitude provided by this approach allows systems to be designed with very short cycle times.

With an input data register, the IDT70V927 has been optimized for applications having unidirectional or bidirectional data flow in bursts. An automatic power down feature, controlled by $\overline{CE}_0$ and CE_1, permits the on-chip circuitry of each port to enter a very low standby power mode. Fabricated using IDT's CMOS high-performance technology, these devices typically operate on only 550mW of power.

Pin configurations(1,2,3)



NOTES:
1. All Vcc pins must be connected to power supply.
2. All GND pins must be connected to ground supply.
3. Package body is approximately 14mm x 20mm x 1.4mm.
4. This package code is used to reference the package diagram.
5. This text does not indicate orientation of the actual part-marking.

Pin Names

Left Port	Right Port	Names
$\overline{CE}_{0L}$, CE_{1L}	$\overline{CE}_{0R}$, CE_{1R}	Chip Enables
$R/\overline{W}_L$	$R/\overline{W}_R$	Read/Write Enable
$\overline{OE}_L$	$\overline{OE}_R$	Output Enable
A_{0L} - A_{14L}	A_{0R} - A_{14R}	Address
I/O_{0L} - I/O_{15L}	I/O_{0R} - I/O_{15R}	Data Input/Output
CLK_L	CLK_R	Clock
$\overline{UB}_L$	$\overline{UB}_R$	Upper Byte Select
$\overline{LB}_L$	$\overline{LB}_R$	Lower Byte Select
$\overline{ADS}_L$	$\overline{ADS}_R$	Address Strobe
$\overline{CNTEN}_L$	$\overline{CNTEN}_R$	Counter Enable
$\overline{CNTRST}_L$	$\overline{CNTRST}_R$	Counter Reset
V_{CC}		Power
GND		Ground

3749 tbl 01

Truth Table I—Read/Write and Enable Control(1,2,3)

$\overline{OE}$	CLK	$\overline{CE}_0$	CE_1	$\overline{UB}$	$\overline{LB}$	$R/\overline{W}$	Upper Byte I/O_{8-15}	Lower Byte I/O_{0-7}	Mode
X	↑	H	X	X	X	X	High-Z	High-Z	Deselected—Power Down
X	↑	X	L	X	X	X	High-Z	High-Z	Deselected—Power Down
X	↑	L	H	H	H	X	High-Z	High-Z	Both Bytes Deselected
X	↑	L	H	L	H	L	D_{IN}	High-Z	Write to Upper Byte Only
X	↑	L	H	H	L	L	High-Z	D_{IN}	Write to Lower Byte Only
X	↑	L	H	L	L	L	D_{IN}	D_{IN}	Write to Both Bytes
L	↑	L	H	L	H	H	D_{OUT}	High-Z	Read Upper Byte Only
L	↑	L	H	H	L	H	High-Z	D_{OUT}	Read Lower Byte Only
L	↑	L	H	L	L	H	D_{OUT}	D_{OUT}	Read Both Bytes
H	X	L	H	L	L	X	High-Z	High-Z	Outputs Disabled

3749 tbl 02

NOTES:
1. "H" = V_{IH}, "L" = V_{IL}, "X" = Don't Care.
2. $\overline{ADS}$, $\overline{CNTEN}$, $\overline{CNTRST}$ = X.
3. $\overline{OE}$ is an asynchronous input signal.

Truth Table II—Address Counter Control(1,2)

Address	Previous Address	CLK	$\overline{ADS}$	$\overline{CNTEN}$	$\overline{CNTRST}$	I/O	Mode
X	X	↑	H	H	L	$D_{I/O(0)}$	Counter Reset to Address 0
An	X	↑	L(3)	H	H	$D_{I/O(n)}$	External Address Utilized
X	An	↑	H	H	H	$D_{I/O(n)}$	External Address Blocked—Counter Disabled
X	An	↑	H	L(4)	H	$D_{I/O(n+1)}$	Counter Enable—Internal Address Generation

3749 tbl 03

NOTES:
1. "H" = V_{IH}, "L" = V_{IL}, "X" = Don't Care.
2. $\overline{CE}_0$, $\overline{LB}$, $\overline{UB}$, and $\overline{OE}$ = V_{IL}; CE_1 and R/$\overline{W}$ = V_{IH}.
3. $\overline{ADS}$ is independent of all other signals including $\overline{CE}_0$, CE_1, $\overline{UB}$ and $\overline{LB}$.
4. The address counter advances if $\overline{CNTEN}$ = V_{IL} on the rising edge of CLK, regardless of all other signals including $\overline{CE}_0$, CE_1, $\overline{UB}$ and $\overline{LB}$.

Recommended Operating Temperature and Supply Voltage(1,2)

Grade	Ambient Temperature	GND	Vcc
Commercial	0°C to +70°C	0V	3.3V ± 0.3V
Industrial	-40°C to +85°C	0V	3.3V ± 0.3V

3749 tbl 04

NOTES:
1. This is the parameter T_A.
2. Industrial temperature: for specific speeds, packages and powers contact your sales office.

Recommended DC Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply Voltage	3.0	3.3	3.6	V
GND	Ground	0	0	0	V
V_{IH}	Input High Voltage	2.2	—	V_{CC} + 0.3V	V
V_{IL}	Input Low Voltage	-0.3(2)	—	0.8	V

3749 tbl 05

NOTES:
1. V_{TERM} must not exceed V_{CC} + 0.3V.
2. $V_{IL} \geq$ -1.5V for pulse width less than 10ns.

Absolute Maximum Ratings(1)

Symbol	Rating	Commercial & Industrial	Unit
V_{TERM}(2)	Terminal Voltage with Respect to GND	-0.5 to +4.6	V
T_{BIAS}	Temperature Under Bias	-55 to +125	°C
T_{STG}	Storage Temperature	-55 to +125	°C
I_{OUT}	DC Output Current	50	mA

3749 tbl 06

NOTES:
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. V_{TERM} must not exceed V_{CC} + 0.3V for more than 25% of the cycle time or 10ns maximum, and is limited to $\leq$ 20mA for the period of $V_{TERM} \geq V_{CC}$ + 0.3V.

Capacitance(1) (T_A = +25°C, f = 1.0MHz)

Symbol	Parameter	Conditions(2)	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 3dV	9	pF
C_{OUT}(3)	Output Capacitance	V_{OUT} = 3dV	10	pF

3749 tbl 07

NOTES:
1. These parameters are determined by device characterization, but are not production tested.
2. 3dV references the interpolated capacitance when the input and output switch from 0V to 3V or from 3V to 0V.
3. C_{OUT} also references $C_{I/O}$.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range (Vcc = 3.3V ± 0.3V)

Symbol	Parameter	Test Conditions	70V927S Min.	70V927S Max.	70V927L Min.	70V927L Max.	Unit
$\|I_{LI}\|$	Input Leakage Current[1]	V_{CC} = 3.3V, V_{IN} = 0V to V_{CC}	—	10	—	5	µA
$\|I_{LO}\|$	Output Leakage Current	$\overline{CE}_0 = V_{IH}$ or $CE_1 = V_{IL}$, V_{OUT} = 0V to V_{CC}	—	10	—	5	µA
V_{OL}	Output Low Voltage	I_{OL} = +4mA	—	0.4	—	0.4	V
V_{OH}	Output High Voltage	I_{OH} = -4mA	2.4	—	2.4	—	V

3749 tbl 08

NOTE:
1. At Vcc ≤ 2.0V input leakages are undefined.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range(6,7) (Vcc = 3.3V ± 0.3V)

Symbol	Parameter	Test Condition	Version		70V927X25 Com'l Only Typ.[4]	70V927X25 Com'l Only Max.	70V927X30 Com'l Only Typ.[4]	70V927X30 Com'l Only Max.	Unit
I_{CC}	Dynamic Operating Current (Both Ports Active)	$\overline{CE}_L$ and $\overline{CE}_R = V_{IL}$ Outputs Open f = f_{MAX}[1]	COM'L	S L	120 120	220 185	110 110	210 175	mA
			IND	S L	— —	— —	— —	— —	
I_{SB1}	Standby Current (Both Ports - TTL Level Inputs)	$\overline{CE}_L = \overline{CE}_R = V_{IH}$ f = f_{MAX}[1]	COM'L	S L	30 30	50 40	30 30	50 40	mA
			IND	S L	— —	— —	— —	— —	
I_{SB2}	Standby Current (One Port - TTL Level Inputs)	$\overline{CE}_{"A"} = V_{IL}$ and $\overline{CE}_{"B"} = V_{IH}$[3] Active Port Outputs Open, f=f_{MAX}[1]	COM'L	S L	90 90	130 115	80 80	120 105	mA
			IND	S L	— —	— —	— —	— —	
I_{SB3}	Full Standby Current (Both Ports - CMOS Level Inputs)	Both Ports $\overline{CE}_R$ and $\overline{CE}_L \geq V_{CC} - 0.2V$ $V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$, f = 0[2]	COM'L	S L	1.0 0.2	5 3	1.0 0.2	5 3	mA
			IND	S L	— —	— —	— —	— —	
I_{SB4}	Full Standby Current (One Port - CMOS Level Inputs)	$\overline{CE}_{"A"} \leq 0.2V$ and $\overline{CE}_{"B"} \geq V_{CC} - 0.2V$[5] $V_{IN} \geq V_{CC} - 0.2V$ or $V_{IN} \leq 0.2V$, Active Port Outputs Open, f = f_{MAX}[1]	COM'L	S L	80 80	125 110	70 70	115 100	mA
			IND	S L	— —	— —	— —	— —	

3749 tbl 09

NOTES:
1. At f = f_{MAX}, address and control lines (except Output Enable) are cycling at the maximum frequency clock cycle of $1/t_{CYC}$, using "AC TEST CONDITIONS" at input levels of GND to 3V.
2. f = 0 means no address, clock, or control lines change. Applies only to input at CMOS level standby.
3. Port "A" may be either left or right port. Port "B" is the opposite from port "A".
4. V_{CC} = 3.3V, T_A = 25°C for Typ, and are not production tested. $I_{CC\,DC}$(f=0) = 90mA (Typ).
5. $\overline{CE}_X = V_{IL}$ means $\overline{CE}_{0X} = V_{IL}$ and $CE_{1X} = V_{IH}$
   $\overline{CE}_X = V_{IH}$ means $\overline{CE}_{0X} = V_{IH}$ or $CE_{1X} = V_{IL}$
   $\overline{CE}_X \leq 0.2V$ means $\overline{CE}_{0X} \leq 0.2V$ and $CE_{1X} \geq V_{CC} - 0.2V$
   $\overline{CE}_X \geq V_{CC} - 0.2V$ means $\overline{CE}_{0X} \geq V_{CC} - 0.2V$ or $CE_{1X} \leq 0.2V$
   "X" represents "L" for left port or "R" for right port.
6. 'X' in part numbers indicate power rating (S or L).
7. Industrial temperature: for specific speeds, packages and powers contact your sales office.

AC Test Conditions

Input Pulse Levels	GND to 3.0V
Input Rise/Fall Times	3ns Max.
Input Timing Reference Levels	1.5V
Output Reference Levels	1.5V
Output Load	Figures 1,2 and 3

3749 tbl 10

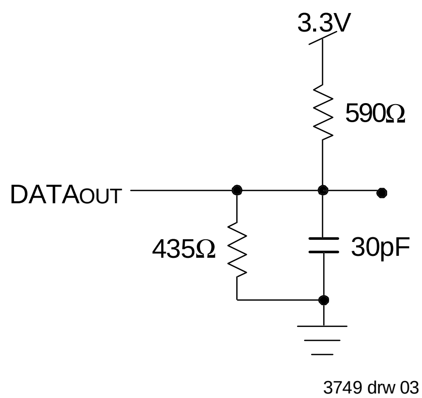


Figure 1. AC Output Test load.

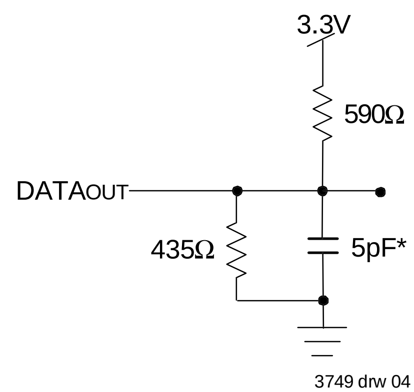


Figure 2. Output Test Load
(For t_{CKLZ}, t_{CKHZ}, t_{OLZ}, and t_{OHZ}).
*Including scope and jig.

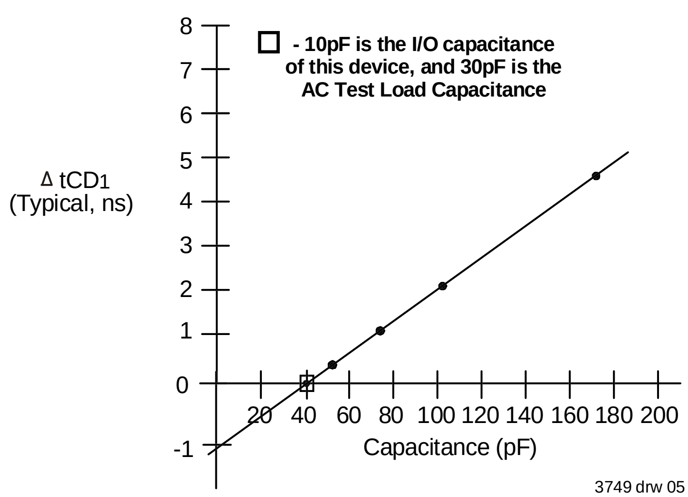


Figure 3. Typical Output Derating (Lumped Capacitive Load).

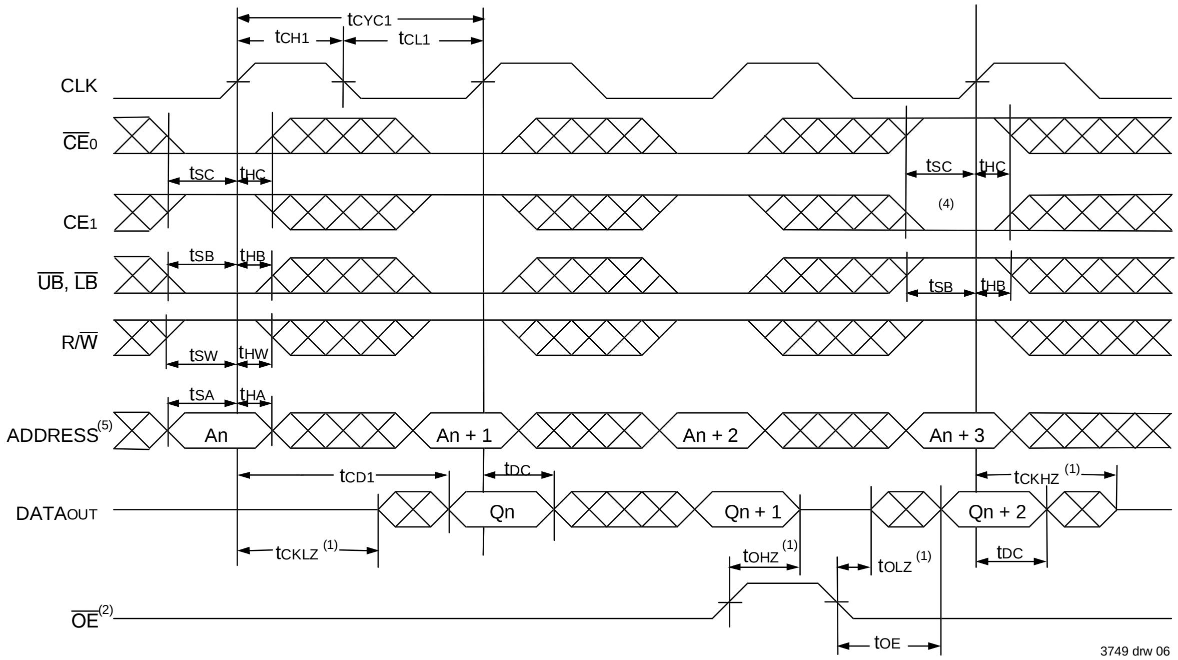
AC Electrical Characteristics Over the Operating Temperature Range (Read and Write Cycle Timing)(2,3,4) (Vcc = 3.3V ± 0.3, TA = 0°C to +70°C)

		70V927X25 Com'l Only		70V927X30 Com'l Only		
Symbol	Parameter	Min.	Max.	Min.	Max.	Unit
t_{CYC1}	Clock Cycle Time (Flow-Through)(2)	30	—	35	—	ns
t_{CH1}	Clock High Time (Flow-Through)(2)	12	—	12	—	ns
t_{CL1}	Clock Low Time (Flow-Through)(2)	12	—	12	—	ns
t_R	Clock Rise Time	—	3	—	3	ns
t_F	Clock Fall Time	—	3	—	3	ns
t_{SA}	Address Setup Time	4	—	4	—	ns
t_{HA}	Address Hold Time	1	—	1	—	ns
t_{SC}	Chip Enable Setup Time	4	—	4	—	ns
t_{HC}	Chip Enable Hold Time	1	—	1	—	ns
t_{SB}	Byte Enable Setup Time	4	—	4	—	ns
t_{HB}	Byte Enable Hold Time	1	—	1	—	ns
t_{SW}	R/$\overline{W}$ Setup Time	4	—	4	—	ns
t_{HW}	R/$\overline{W}$ Hold Time	1	—	1	—	ns
t_{SD}	Input Data Setup Time	4	—	4	—	ns
t_{HD}	Input Data Hold Time	1	—	1	—	ns
t_{SAD}	$\overline{ADS}$ Setup Time	4	—	4	—	ns
t_{HAD}	$\overline{ADS}$ Hold Time	1	—	1	—	ns
t_{SCN}	$\overline{CNTEN}$ Setup Time	4	—	4	—	ns
t_{HCN}	$\overline{CNTEN}$ Hold Time	1	—	1	—	ns
t_{SRST}	$\overline{CNTRST}$ Setup Time	4	—	4	—	ns
t_{HRST}	$\overline{CNTRST}$ Hold Time	1	—	1	—	ns
t_{OE}	Output Enable to Data Valid	—	12	—	15	ns
t_{OLZ}	Output Enable to Output Low-Z(1)	2	—	2	—	ns
t_{OHZ}	Output Enable to Output High-Z(1)	1	7	1	7	ns
t_{CD1}	Clock to Data Valid (Flow-Through)	—	25	—	30	ns
t_{DC}	Data Output Hold After Clock High	2	—	2	—	ns
t_{CKHZ}	Clock High to Output High-Z(1)	2	9	2	9	ns
t_{CKLZ}	Clock High to Output Low-Z(1)	2	—	2	—	ns
Port-to-Port Delay						
t_{CWDD}	Write Port Clock High to Read Data Delay	—	40	—	50	ns
t_{CCS}	Clock-to-Clock Setup Time	—	15	—	20	ns

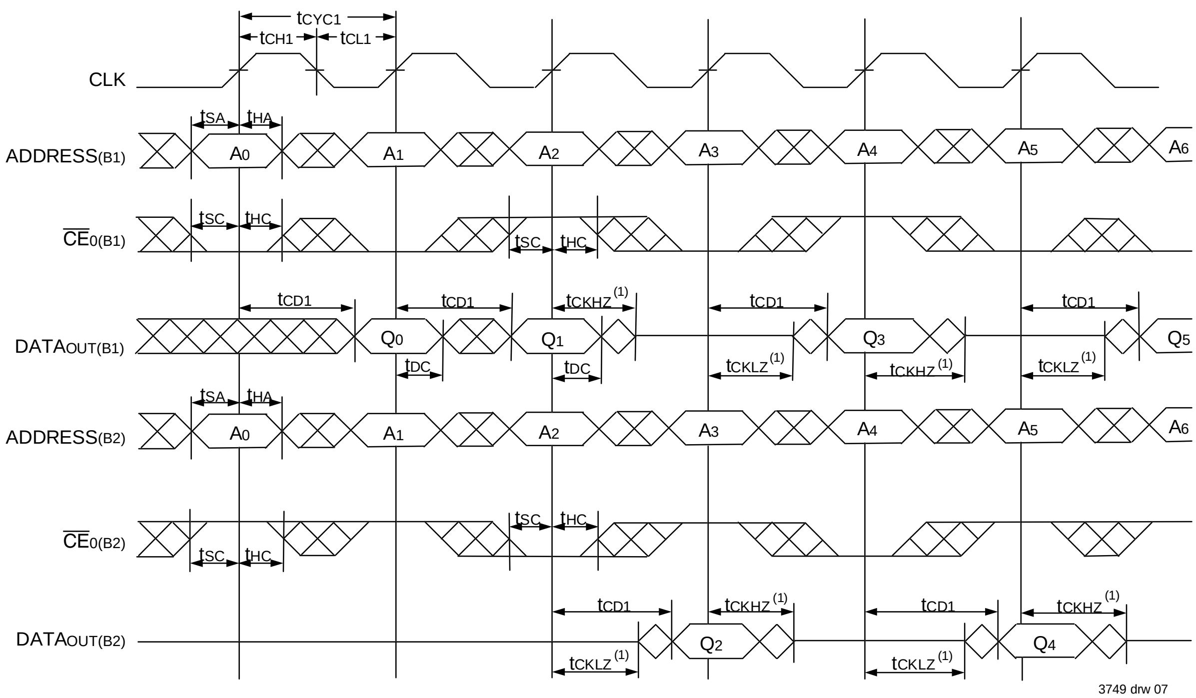
3749 tbl 11

NOTES:
1. Transition is measured ±200mV from Low or High-impedance voltage with the Output Test Load (Figure 2). This parameter is guaranteed by device characterization, but is not production tested.
2. All input signals are synchronous with respect to the clock except for the asynchronous Output Enable ($\overline{OE}$).
3. 'X' in part number indicates power rating (S or L).
4. Industrial temperature: for specific speeds, packages and powers contact your sales office.

Timing Waveform of Read Cycle for Flow-Through Output[3]



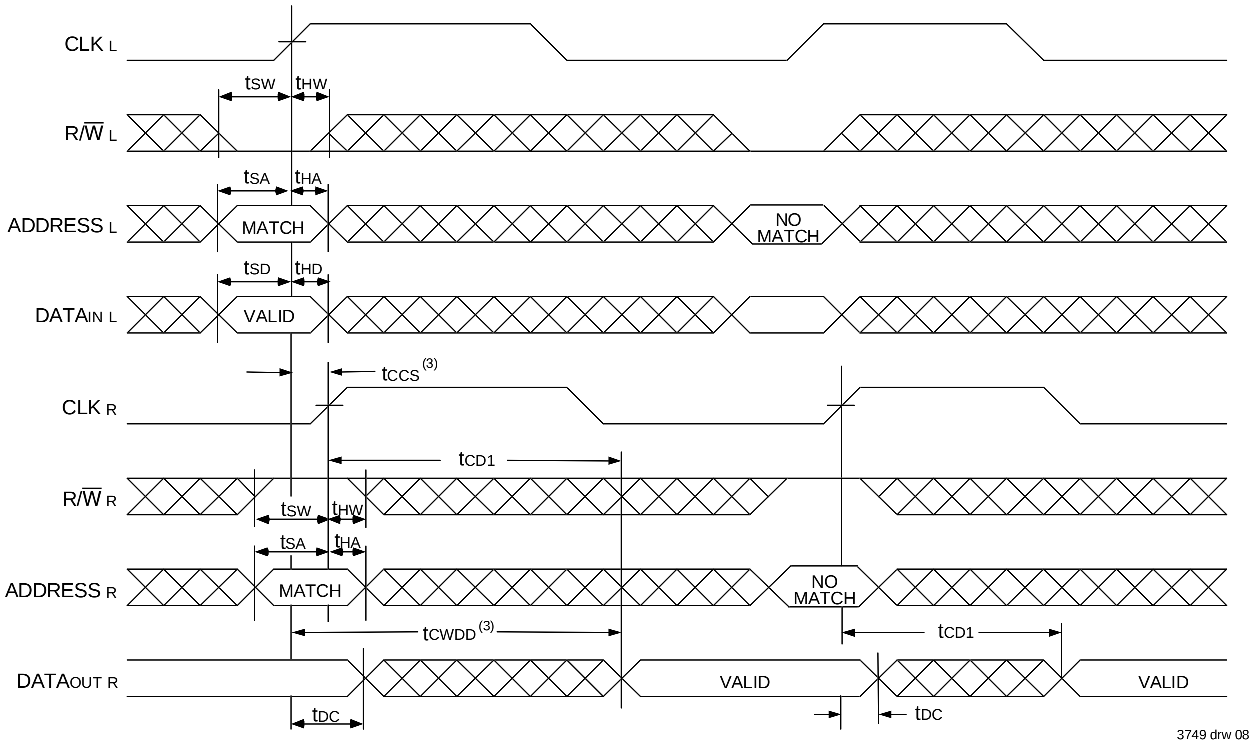
Timing Waveform of a Bank Select Flow-Through Read[6,7]



NOTES:

1. Transition is measured ±200mV from Low or High-impedance voltage with the Output Test Load (Figure 2).
2. $\overline{OE}$ is asynchronously controlled; all other inputs are synchronous to the rising clock edge.
3. $\overline{ADS}$ = V_{IL}, $\overline{CNTEN}$ and $\overline{CNTRST}$ = V_{IH}.
4. The output is disabled (High-impedance state) by $\overline{CE}_0$ = V_{IH}, CE_1 = V_{IL}, $\overline{UB}$ = V_{IH}, or $\overline{LB}$ = V_{IH} following the next rising edge of the clock. Refer to Truth Table 1.
5. Addresses do not have to be accessed sequentially since $\overline{ADS}$ = V_{IL} constantly loads the address on the rising edge of the CLK; numbers are for reference use only.
6. B1 Represents Bank #1; B2 Represents Bank #2. Each Bank consists of one IDT70V927 for this waveform, and are setup for depth expansion in this example. $ADDRESS_{(B1)}$ = $ADDRESS_{(B2)}$ in this situation.
7. $\overline{UB}$, $\overline{LB}$, $\overline{OE}$, and $\overline{ADS}$ = V_{IL}; $CE_{1(B1)}$, $CE_{1(B2)}$, R/$\overline{W}$, $\overline{CNTEN}$, and $\overline{CNTRST}$ = V_{IH}.

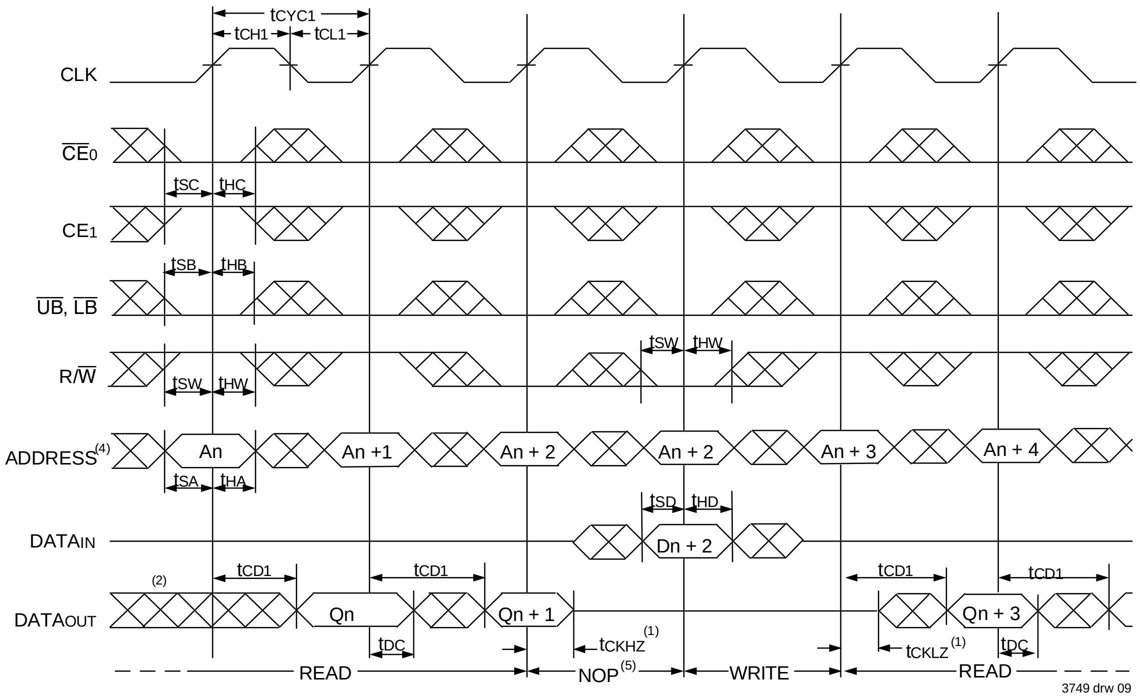
Timing Waveform of Left Port Write to Flow-Through Right Port Read(1,2)



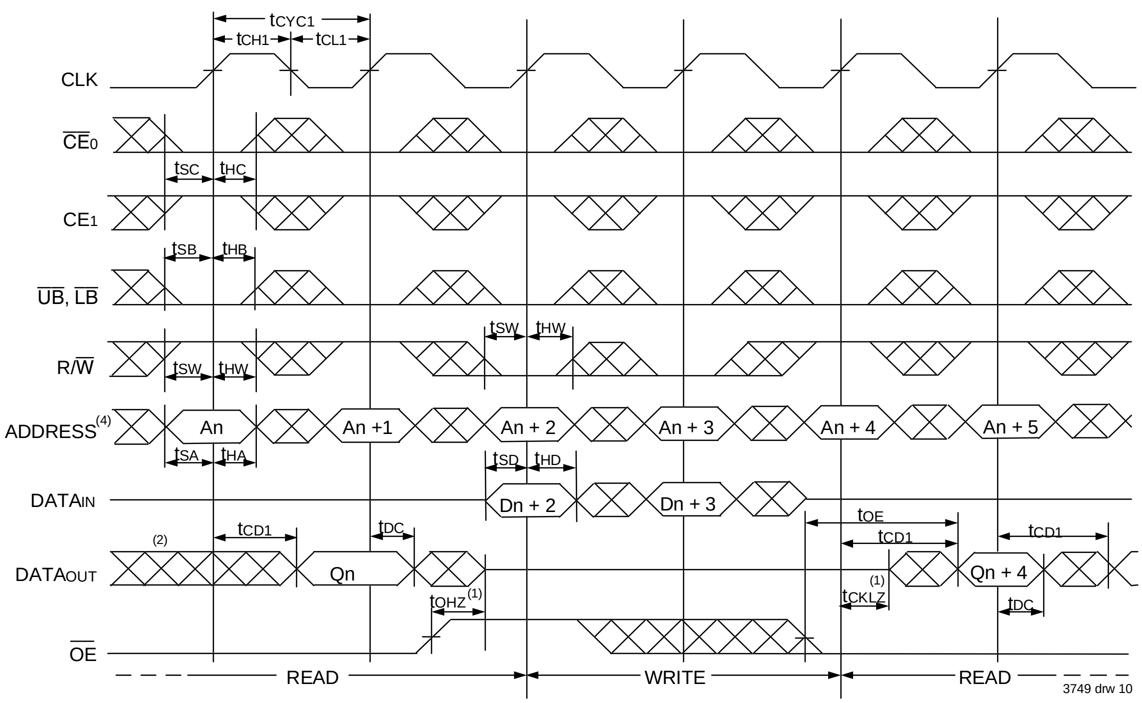
NOTES:

1. $\overline{CE_0}$, $\overline{UB}$, $\overline{LB}$, and $\overline{ADS}$ = V_{IL}; CE_1, $\overline{CNTEN}$, and $\overline{CNTRST}$ = V_{IH}.
2. $\overline{OE}$ = V_{IL} for the Right Port, which is being read from. $\overline{OE}$ = V_{IH} for the Left Port, which is being written to.
3. If $t_{CCS} \leq$ maximum specified, then data from right port READ is not valid until the maximum specified for t_{CWDD}.
   If t_{CCS} > maximum specified, then data from right port READ is not valid until $t_{CCS} + t_{CD1}$. t_{CWDD} does not apply in this case.

Timing Waveform of Flow-Through Read-to-Write-to-Read ($\overline{OE}$ = VIL)(3)



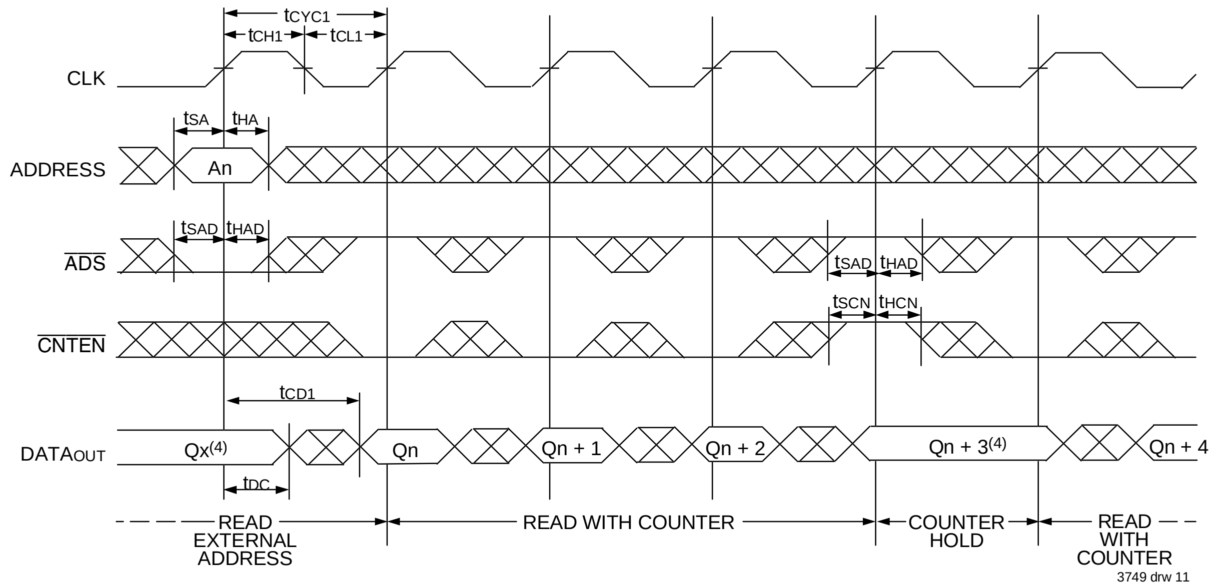
Timing Waveform of Flow-Through Read-to-Write-to-Read ($\overline{OE}$ Controlled)(3)



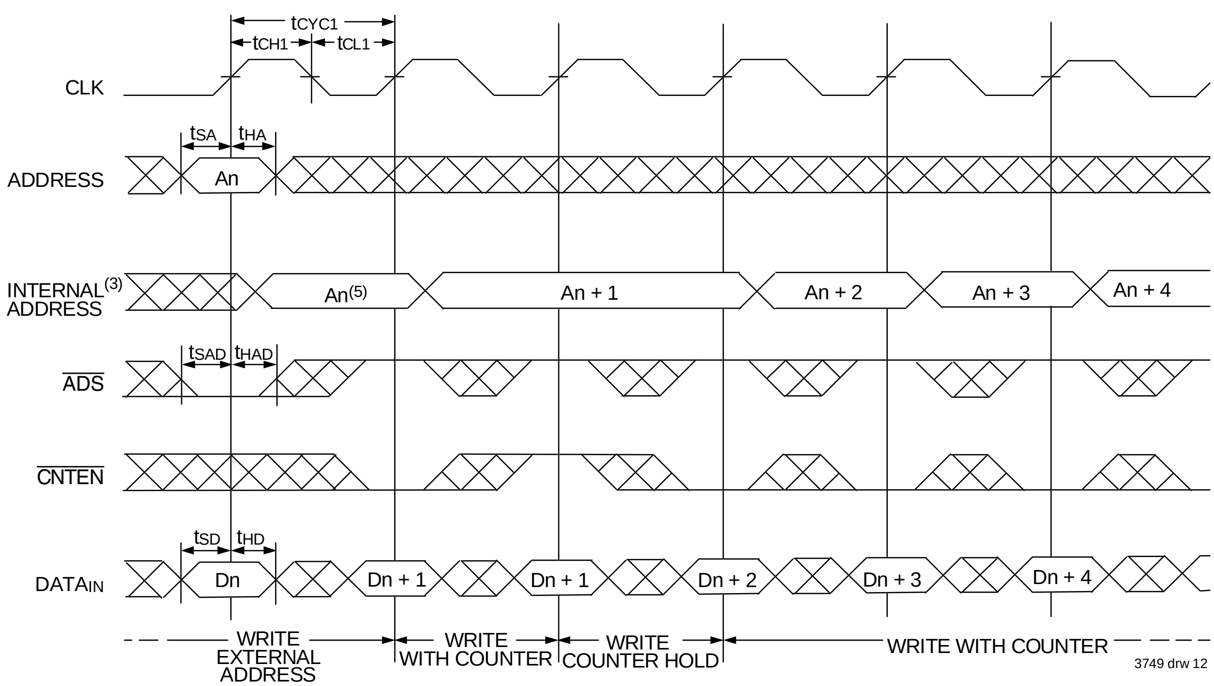
NOTES:

1. Transition is measured ±200mV from Low or High-impedance voltage with the Output Test Load (Figure 2).
2. Output state (High, Low, or High-impedance) is determined by the previous cycle control signals.
3. $\overline{CE_0}$, $\overline{UB}$, $\overline{LB}$, and $\overline{ADS}$ = VIL; CE1, $\overline{CNTEN}$, and $\overline{CNTRST}$ = VIH. "NOP" is "No Operation".
4. Addresses do not have to be accessed sequentially since $\overline{ADS}$ = VIL constantly loads the address on the rising edge of the CLK; numbers are for reference use only.
5. "NOP" is "No Operation." Data in memory at the selected address may be corrupted and should be re-written to guarantee data integrity.

Timing Waveform of Flow-Through Read with Address Counter Advance(1)



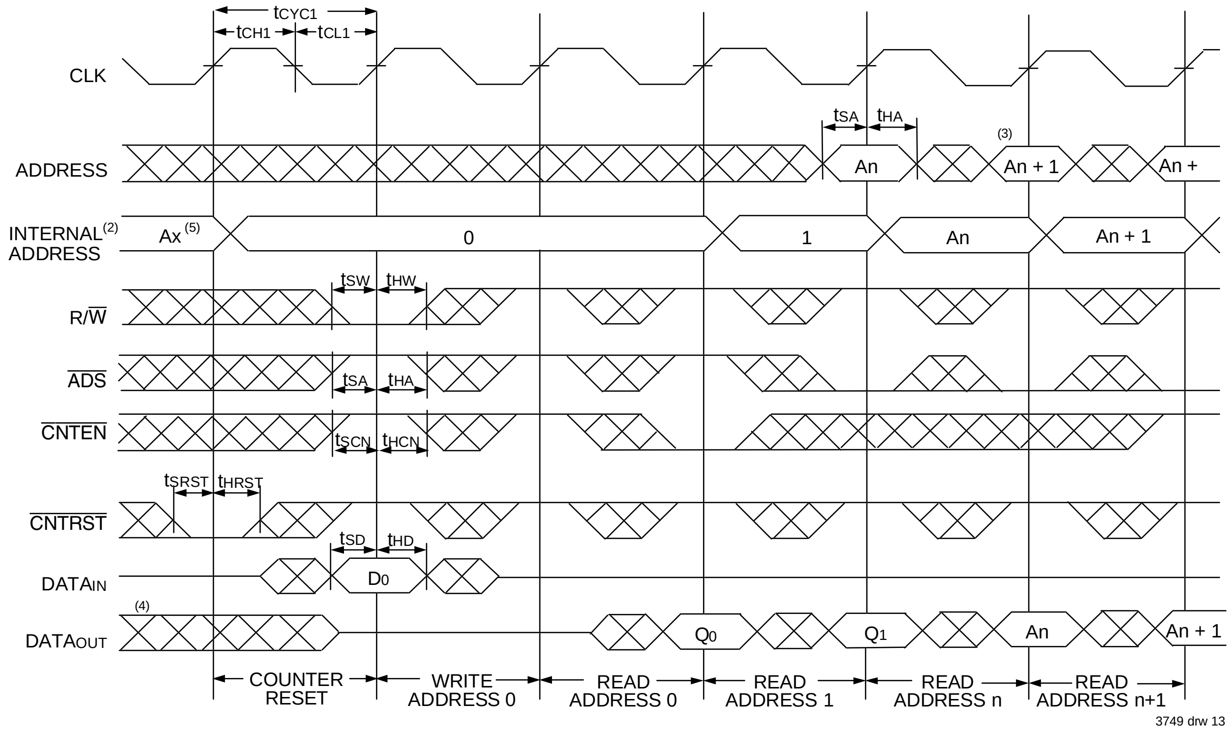
Timing Waveform of Write with Address Counter Advance(2)



NOTES:

1. $\overline{CE}_0$, $\overline{OE}$, $\overline{UB}$, and $\overline{LB}$ = V_{IL}; CE_1, $R/\overline{W}$, and $\overline{CNTRST}$ = V_{IH}.
2. $\overline{CE}_0$, $\overline{UB}$, $\overline{LB}$, and $R/\overline{W}$ = V_{IL}; CE_1 and $\overline{CNTRST}$ = V_{IH}.
3. The "Internal Address" is equal to the "External Address" when $\overline{ADS}$ = V_{IL} and equals the counter output when $\overline{ADS}$ = V_{IH}.
4. If there is no address change via $\overline{ADS}$ = V_{IL} (loading a new address) or $\overline{CNTEN}$ = V_{IL} (advancing the address), i.e. $\overline{ADS}$ = V_{IH} and $\overline{CNTEN}$ = V_{IH}, then the data output remains constant for subsequent clocks.
5. $\overline{CNTEN}$ = V_{IL} advances Internal Address from ‘An’ to ‘An +1’. The transition shown indicates the time required for the counter to advance. The ‘An +1’Address is written to during this cycle.

Timing Waveform of Counter Reset(1)



NOTES:

1. $\overline{CE}_0$, $\overline{UB}$, $\overline{LB}$ = V_{IL}; CE_1 = V_{IH}.
2. The "Internal Address" is equal to the "External Address" when $\overline{ADS}$ = V_{IL} and equals the counter output when $\overline{ADS}$ = V_{IH}.
3. Addresses do not have to be accessed sequentially since $\overline{ADS}$ = V_{IL} constantly loads the address on the rising edge of the CLK; numbers are for reference use only.
4. Output state (High, Low, or High-impedance) is determined by the previous cycle control signals.
5. No dead cycle exists during counter reset. A READ or WRITE cycle may be coincidental with the counter reset. $ADDR_0$ will be accessed. Extra cycles are shown here simply for clarification.

Functional Description

The IDT70V927 provides a true synchronous Dual-Port Static RAM interface. Registered inputs provide minimal set-up and hold times on address, data, and all critical control inputs. All internal registers are clocked on the rising edge of the clock signal, however, the self-timed internal write pulse is independent of the LOW to HIGH transition of the clock signal.

An asynchronous output enable is provided to ease asynchronous bus interfacing. Counter enable inputs are also provided to stall the operation of the address counters for fast interleaved memory applications.

A HIGH on $\overline{CE}_0$ or a LOW on CE_1 for one clock cycle will power down the internal circuitry to reduce static power consumption. Multiple chip enables allow easier banking of multiple IDT70V927's for depth expansion configurations.

Depth and Width Expansion

The IDT70V927 features dual chip enables (refer to Truth Table 1) in order to facilitate rapid and simple depth expansion with no requirements for external logic. Figure 4 illustrates how to control the various chip enables in order to expand two devices in depth.

The IDT70V927 can also be used in applications requiring expanded width, as indicated in Figure 4. Since the banks are allocated at the discretion of the user, the external controller can be set up to drive the input signals for the various devices as required to allow for 32-bit or wider applications.

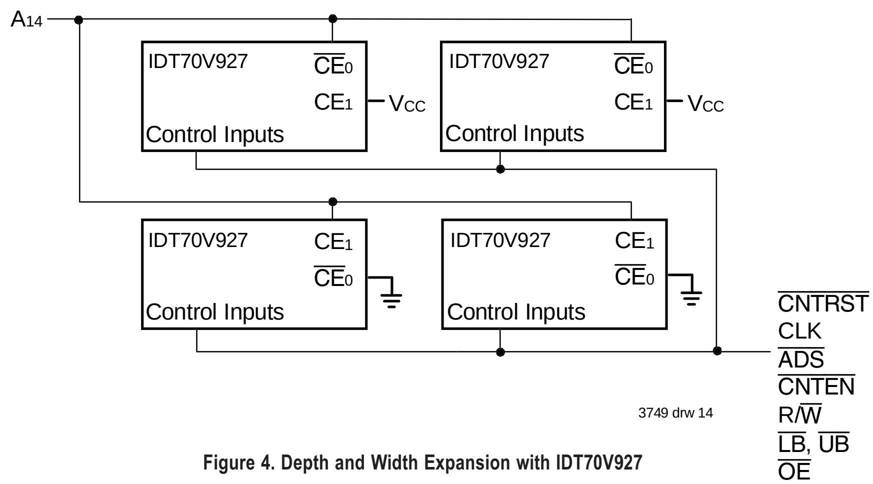


Figure 4. Depth and Width Expansion with IDT70V927

Ordering Information

IDT XXXXX A 99 A A

Device Type | Power | Speed | Package | Process/Temperature Range

Process/Temperature Range:
- Blank — Commercial (0°C to +70°C)
- I(1) — Industrial (-40°C to +85°C)

Package:
- PRF — 128-pin TQFP (PK128-1)

Speed (Speed in nanoseconds):
- 25 — Commercial Only
- 30 — Commercial Only

Power:
- S — Standard Power
- L — Low Power

Device Type:
- 70V927 — 512K (32K x 16-Bit) Synchronous Dual-Port RAM

3749 drw 15

NOTE:
1. Industrial temperature range is available.
   For specific speeds, packages and powers contact your sales office.

Preliminary Datasheet: Definition

"PRELIMINARY" datasheets contain descriptions for products that are in early release.

Datasheet Document History

12/16/98:	Initiated datasheet document history
	Converted to new format
	Cosmetic and typographical corrections
	Added additional notes to pin configurations
	Pages 11 & 12 Updated timing waveforms
	Page 13 Added Depth and Width Expansion section
6/15/99:	Page 4 Deleted note 5 for Table II
9/27/99:	Page 2 Changed pin 111 to GND

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